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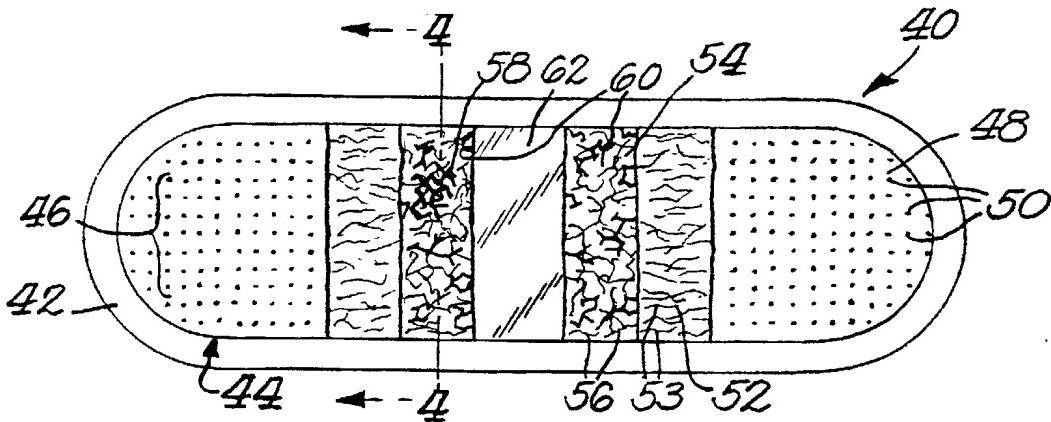
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(54) Title: ABSORBENT AIRLAID STRUCTURE



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(57) Abstract: An absorbent structure (54) is formed as a nonwoven web of a plurality of polyurethane foam particles (58). The foam particles (58) may comprise complete cells or groups of cells and fragments of cells (60). Alternatively, the absorbent structure may be formed as a nonwoven web of a plurality of polyurethane foam cell strands. One embodiment of the invention combines foam particles (58) or foam cell strands (60) or a mixture of particles and strands with wood pulp fibers (56) to form the nonwoven web (54). Combinations ranging from 10 % by weight foam and 90 % by weight wood pulp to 90 % by weight foam and 10 % by weight wood pulp may be used to form the absorbent structure. Optionally, a binder is added to the web. Optionally, a superabsorbent polymer (SAP) is added to the polyol component prior to forming the foam that is then ground to form the foam particles or foam cell strands used in the nonwoven web. Conventional untreated generally hydrophobic polyurethane foams with pore sizes ranging from 10 pores per linear inch to 150 pores per linear inch can be used to form the nonwoven web.

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### Absorbent Airlaid Structure

This invention relates to an nonwoven web structure made by combining together foam particles or fragments or strands of foam cells and wood pulp fibers,  
5 optionally with superabsorbent polymers (SAP). Preferably, the combination of foam particles and wood pulp fibers is airlaid using conventional air-lay equipment to form the nonwoven web structure. In the most preferred embodiment, foam particles or fragments or strands of foam cells alone, without any wood pulp fibers or SAP, are airlaid to form the absorbent composite structure. This new airlaid structure may be  
10 incorporated into absorbent products, such as feminine hygiene products, diapers, wipers, and bed pads, in place of conventional airlaid structures formed of wood pulp alone or wood pulp combined with super-absorbent polymer particles.

### Background of the Invention

15 Absorbent airlaid layers in many absorbent articles are formed from airlaid wood pulp fibers. Using conventional airlaid equipment, such as offered by DAN WEB, a desired amount of wood pulp is fed to a hammer mill, where it is beaten and opened up to form a network of wood pulp fibers. These fibers are carried by blown  
20 air to a lay down chamber, where they are optionally mixed with other components, such as superabsorbent polymers (SAP) and laid against a fine-mesh screen to form a layer of desired thickness. The layer is compressed, and sometimes a binder is added, to hold the structure together. In other cases, thermal bonding using thermoplastic fibers mixed with the pulp, is used to hold the structure together. The compressed  
25 layer, sometimes called nonwoven "airfelt", is then transferred from the screen and

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incorporated into the construction of a diaper or catamenial pad or other absorbent product.

When wood pulp fibers are compressed together severely, the compression reduces the fiber loft and void volume between the fibers, and lessens the absorbent capability, especially when a binder is used to hold the web together. Superabsorbent polymers are blended or layered with the wood pulp, to enhance the liquid absorbency and liquid retaining properties of the absorbent product. The compressed pulp layer with added SAP has been found to achieve acceptable absorbency rates and liquid retention. However, compared to wood pulp fibers alone, the absorbent structures incorporating superabsorbent polymers are much more expensive.

Efforts have been made to incorporate foams into absorbent products. U.S. Patent No. 5,849,805 (Dyer) proposes forming an absorbent foam by polymerizing high internal phase emulsions (HIPEs) and using that foam, preferably in sheet form, as a component of an absorbent article. The Dyer patent notes at Col. 2, lines 44 *et seq.* that other efforts to incorporate foams into absorbent articles have been tried. The Dyer patent does not disclose forming an absorbent core using polyurethane foam particles alone or in combination with wood pulp fiber to form an absorbent layer.

U.S. Patent No. 5,506,035 (Van Phan) discloses a superabsorbent polymer foam that is formed by foaming a superabsorbent polymer (hydrogel). A reaction mixture of a monomer, an internal cross-linking agent and a solvent is mixed with a blowing agent to form a dispersion. Then the blowing agent is expanded and the monomer and cross-linking agent are reacted to form the superabsorbent polymer material. Van Phan prefers to use the superabsorbent polymer foam in sheet form as a

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layer in the absorbent core in the diaper or sanitary napkin. The foam layer may be formed on top of an airlaid pulp fiber web (Col. 38, lines 5-24). Van Phan also suggests dispersing particles of the superabsorbent polymer foam into the airlaid pulp fiber web (Col. 40, line 50 to Col. 41, line 9). The Van Phan patent does not disclose forming an absorbent core using polyurethane foam particles alone or in combination with wood pulp fiber.

10

Van Phan refers to U.S. Patent No. 4,610,678 (Weisman). Weisman discloses a process for making an absorbent structure by air-laying a mixture of hydrophilic fibers (such as cellulose or wood pulp, rayon and polyester fibers) and particles of water-insoluble hydrogel. The Weisman patent does not disclose forming an absorbent core using polyurethane foam particles alone or in combination with wood pulp fiber.

15

Conventional polyurethane foams are hydrophobic, unless chemical alterations are made to increase hydrophilicity. It is therefore surprising that adding particles or fragments of such untreated foam cells to wood pulp fibers improves liquid absorption, wicking and liquid retention. It is most surprising that a nonwoven web formed of fragments of polyurethane foam particles alone can be used as an absorbent structure with satisfactory liquid wicking and retaining properties. Such structures are less expensive alternatives to known absorbent structures that require SAP or higher quantities of SAP to achieve these properties.

20

### Summary of the Invention

An absorbent structure is formed from a plurality of polyurethane foam particles combined together into a nonwoven web. If a fine celled foam is used with

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cell sizes in the range of 100 to 150 pores per linear inch, the foam is ground to particles of 0.10 to 2.6 mm. Such particles have complete foam cells and portions of foam cells joined together. If a coarse foam is used with cell sizes in the range of 10 to 30 pores per linear inch, the foam is ground to particles of 0.40 to 2.6 mm. The 5 resulting ground particles generally are fragments of foam cells or foam cell struts, but may also be a combination of complete foam cells and partial foam cell fragments. It is also acceptable to use foams with pore sizes from 60 to 90 pores per linear inch by grinding such foams to particles of 0.40 to 2.6 mm as the longest dimension.

The nonwoven web formed with the polyurethane foam particles or fragments 10 of polyurethane foam cells has a three-dimensional network structure of inter-linking particles. The open-celled foam can be reticulated to remove the windows that form in the openings defined by the foam cell struts in a typical open-celled polyurethane foam. Because the polyurethane foam forms dodecahedron-shaped cells (with twelve sides), the cell struts are interconnected together and form bent angles and bent 15 shapes. Unlike wood pulp fibers, which form "two-dimensional" flexible fibers of defined width that are cut to desired length and do not have bent angles, the foam cell strands or struts form bent angles and three-dimensional shapes. The inter-linking of these foam particles and foam strands creates an open network of voids into which liquids may flow and be contained.

20 In one embodiment of the invention, the absorbent structure is made by combining foam particles and wood pulp fibers into a nonwoven web. The foam may be a polyether or polyester polyurethane foam. Preferably the foam is hydrophobic, but hydrophilic foam may also be used. The wood pulp and foam particles or particles

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and strands are mixed together to form the nonwoven web. Preferably, the web is formed by air-laying the wood pulp fibers and foam particles. The foam particles may range from 10% by weight to 90% by weight of the nonwoven web. The wood pulp fibers may range from 90% by weight to 10% by weight of the nonwoven web.

- 5      Optionally, a binder may be added to hold the web together. Optionally, the polyurethane foam may be formed with a superabsorbent polymer incorporated into the polyol component prior to foaming (*See U.S. Pat. No. 4,985,467 (Kelly)*). Superabsorbent polymer particles may also be combined with the separate polyurethane foam particles and wood pulp fibers to form the web, but this is a less  
10     preferred embodiment because loose super absorbent polymer particles tend to come out of the web.

The combined wood pulp and foam particles or foam cell fragments form an inter-locking network. The three-dimensional aspect of the foam particles or cell fragments serves to separate the wood pulp fibers to form voids or channels into  
15     which liquid may flow and be retained.

#### Description of the Figures

FIG. 1 is a top plan view of a prior art multi-layered absorbent pad product  
20     showing the construction details by breaking away various layers;

FIG. 2 is a fragmental cross-sectional view of the prior art pad product taken along line 2-2 of FIG. 1;

FIG. 3 is a top plan view of a multi-layered absorbent pad product showing the construction details by breaking away various layers, wherein one layer comprises the

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absorbent airlaid structure of the invention;

FIG. 4 is a fragmental cross-sectional view of the pad product taken along line 4-4 of FIG. 3;

FIG. 5 is an enlarged schematic view showing a typical orientation of wood  
5 pulp fibers used to make the absorbent airlaid structure in one embodiment of the  
invention;

FIG. 6 is an enlarged perspective view of a reticulated foam cell;

FIG. 7 is an enlarged perspective view of a network of reticulated foam cells;

FIG. 8 is an enlarged perspective view of fragments of reticulated foam cells;  
10 and

FIG. 9 is an enlarged schematic view showing the combination of airlaid wood  
pulp fibers and fragments of reticulated foam cells used to form the absorbent airlaid  
structure of the invention.

## 15 Description of the Preferred Embodiments

The absorbent structure of the invention may be incorporated into a variety of  
absorbent products. Use of the absorbent structure in feminine hygiene products will  
now be described.

20 FIG. 1 shows a prior art feminine hygiene pad product **10** having a generally  
oblong shape with a central portion **12** surrounded by a terminal edge **13**. Extending  
from the terminal edge **13** are side wings **14**. A liquid absorbing and retaining core  
portion **16** is found within the central portion **12** of the pad **10**.

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The core portion 16 defines a number of layers. FIG. 1 shows the top plan view of the pad 10 with the several layers of the core portion 16 broken away. FIG. 2 shows a cross-sectional view of the core portion 16 and the configuration of the various layers.

5 A perforated top sheet 18 comprises the top surface of the core portion 16. The perforated top sheet 18 defines perforations 20. Liquid contacting the top surface of the perforated top sheet 18 wicks through the sheet through perforations 20. Preferably, the perforated top sheet has a hydrophilic character on its top surface and a hydrophobic character on its bottom surface so that liquid penetrating through the  
10 perforations 20 does not readily reverse its flow direction to rewet the top surface. Some prior art absorbent pad structures use a nonwoven sheet as the top sheet in place of an apertured or perforated top sheet.

Below the perforated top sheet 18 is an airfelt transfer sheet 22. The transfer sheet 22 is formed from airlaid wood pulp fibers. Liquid passing through the  
15 perforated top sheet 18 and contacting the transfer sheet 22 is drawn away from the perforated top sheet 18 by the transfer sheet 22.

Below the transfer sheet 22 is an absorbent air felt wood pulp core 24. The core is formed from airlaid wood pulp fibers 26. In this prior art pad 10, the absorbent air felt wood pulp core 24 is formed from a single discrete layer of air felt that is  
20 folded around a layer of superabsorbent polymer particles 28. The air felt is folded at two places to form a C-fold around the superabsorbent polymer particles 28. The ends of this C-fold abut together and overlap at a central point 29 below the layer of superabsorbent particles 28. The combination of wood pulp core 24 and

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superabsorbent polymer particles **28** absorbs and retains liquids collected by the core portion of the pad.

A liquid impermeable back sheet **30** is below the absorbent air felt wood pulp core **24**. This sheet prevents liquid held within the core portion **16** from penetrating through. Pressure-sensitive, hot melt adhesive (not shown) is applied to the outer surface of the liquid impermeable back sheet **30** to removably attach the pad to undergarments when in use. This adhesive is applied to the outer surface of the liquid impermeable back sheet **30** below the core portion **16** as well as on the side wings **14**.

Referring next to FIGs. 3 and 4, a feminine hygiene pad **40** that incorporates the absorbent structure **54** according to the invention is shown. The pad is of generally oblong shape and has a central portion **44** surrounded by a terminal edge **42**. The absorbent core portion **46** is shown from the top in FIG. 3 and in cross-sectional view in FIG. 4. The various layers of the core portion **46** are shown partially broken away from the outermost layer to the bottom-most layer.

Like the prior art pad **10**, the top surface of the pad **40** is a perforated top sheet **48**. Liquid contacting the top surface of the top sheet **48** passes through perforations **50**.

Below the perforated top sheet **48** is an airfelt transfer sheet **52** that has wood pulp fibers **53** formed into a nonwoven airlaid web. Liquid transmitted through the top sheet **48** is absorbed into the airfelt transfer sheet **52** and delivered to the absorbent core structure **54** that is below the airfelt transfer sheet **52**.

The absorbent core structure **54** according to the invention is a web formed from a mixture of wood pulp fibers **56** and foam particles **58** and/or foam cell

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fragments 60. Preferably, the wood pulp fibers 56 and foam particles 58 or foam cell fragments 60 are mixed together in an air handler and airlaid against a screen to form a nonwoven web. The foam cell strands 60 entangle with the wood pulp fibers 56 to create void volumes and channels to transport and hold liquid and improve wicking  
5 and absorbency of the absorbent structure 54.

A liquid impermeable backing sheet 62 is positioned below the absorbent structure 54. Pressure-sensitive, hot melt adhesive (not shown) is applied to the outer surface of the liquid impermeable backing sheet 62 to enable the pad to be removably attached to an undergarment.

10 The absorbent structure 54 according to the invention may be made in different ways. One way would be to mix the wood pulp fibers and foam particles or foam cell strands (or a combination of these) together with water and binder to form a slurry that may be wet-formed into a non-woven web.

15 Another way would be to combine the wood pulp fibers and foam particles or foam cell strands with a binder and compress this mixture in a mold. While under compression, the binder is cured with heat or steam to form the molded product. Portions of the molded product are then peeled away to form a layer that may be used as the absorbent structure incorporated into an absorbent article.

20 Preferably, however, the wood pulp fibers and foam particles or foam cell strands are mixed together in a dry state, transferred to a vacuum screen, optionally sprayed with a liquid binder, air laid to form a nonwoven web of desired thickness, calendered as compressed to fix the fibers and particles, and then dried. The web so formed may be used as is, or may be plied with other layers as required.

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As shown in FIG. 5, wood pulp fibers are strands with consistent diameters that may be cut to desired lengths. Weyerhauser soft pine and bleached Southern pine pulp fibers have been found particularly suitable for used when making the absorbent structure according to one embodiment of the invention. Other wood pulp fibers, such as International Paper soft pine wood pulp fibers, may be used.

An enlarged view of a typical reticulated open cell polyurethane foam cell 70 is shown in FIG. 6. Polyurethane foam cells have interconnected struts 72 that form twelve-sided dodecahedrons. The open spaces between the struts 72 are called faces or windows 74. The polymeric material once in the windows is removed when the foam is reticulated.

Most open-celled polyurethane foams have resilience, which means the foam material tends to return to its uncompressed state once any applied load has been removed. This resilience remains to an extent even if the foam material has been broken apart into pieces with one or more cells, or even into pieces that consist solely of fragments of foam cells.

Particles of the foam, which may contain a number of foam cells in an interconnected network as shown in FIG. 7, may be used to form the absorbent structure according to the invention. If solely foam particles are used, they are mixed together to form the nonwoven web. Unlike wood pulp fibers, which may crush together and densify, the resilient foam cells define and retain void volumes to absorb and hold liquid.

Foam cell fragments also may be used to form the absorbent structure according to the invention. If solely foam cell fragments are used, they are mixed

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together to form the nonwoven web. Foam cell fragments are shown prior to mixing in FIG. 8.

FIG. 9 shows a schematic view of an absorbent structure according to the invention in which a mixture of wood pulp fibers 56 and foam cell fragments 60 forms a nonwoven web. The bent foam cell fragments have a three-dimensional character that combines with their resiliency and in conjunction with the wood pulp fibers creates capillarity to improve liquid-wicking and create void volumes into which absorbed liquid may flow and be retained.

Although not required, the liquid absorption and retaining properties of the nonwoven web absorbent structures according to the invention may be improved by incorporating superabsorbent polymer into the polyurethane foam before the foam is ground into foam cell particles or foam cell fragments. In one preferred embodiment, the polyurethane foam is formed with a polyol dispersion that includes one or more superabsorbent polymers. The superabsorbent polymer may also be coated onto the exterior surface of the foam cell particles or foam cell fragments before forming the nonwoven web. If a superabsorbent polymer is used as a coating or is incorporated directly into the foam composition, best results are achieved by forming the absorbent structure with an airlaid process is preferred over a wet-forming process.

Representative superabsorbent polymers that may be used include NORSOCRYL S35 available from Elf Atochem, CHEMDAL ASAP 2000 and 2001 available from Stock Hausen, SANWET IM-3000, IM-1000 and IM-4510 available from Hoechst Celanese, and WATERLOCK J-500 and A-100 available from Grain Processing Company.

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The polyurethane foam may be formed with polyether or polyester polyols, although the final end use may dictate the preferred system.

Polyurethane foams may be formed with cell sizes in the range of from 3 to 150 pores per linear inch. We have found that the coarse-celled foams, with pore 5 sizes from 10 to 30 pores per linear inch work best when ground to form foam cell fragments having at least once full pore per fragment, with each fragment not exceeding 2.6 mm in its longest dimension, from tip to tip. Preferably, the fragments/particles have a mean particle size in the range of 0.70 to 2.6 mm.

We have found that fine celled foams, with pore sizes from 100 to 150 pores 10 per linear inch work best when ground to form foam particles having at least one full cell per particle and preferably having multiple cells per particle, with each particle not exceeding 2.6 mm in its longest dimension, from tip to tip. Preferably, the fragments/particles have a mean particle size in the range of 0.10 to 2.6 mm.

Other foams with pore sizes between the very coarse and the very fine celled 15 foams may be used in the invention. The foams may be ground to desired particle sizes or foam cell fragment sizes to achieve desired results. We have used foams with pore sizes from 60 to 90 pores per linear inch and ground them to particle sizes from up to 2.6 mm, measuring the longest dimension from tip to tip. Preferably, the fragmented particles have a mean particle size in the range of 0.40 to 2.6 mm.

Because the absorbent structures of the present invention are highly absorbent, 20 and may be made entirely without or with much less quantity of expensive superabsorbent polymer, they are extremely well suited for use in feminine hygiene products and disposable diapers. Sanitary napkins using the present absorbent

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structures may be derived from known sanitary napkins simply by replacing the absorbent core of the known napkins with the absorbent structure according to this invention. Such replacement may be on a weight-by-weight basis, which results in a reduction in volume and a gain in capacity. The absorbent structures used in sanitary napkins preferably have a thickness of from about 1 to 3 mm, more preferably about 1.5 to 2 mm. However, absorbent structures of thickness less than 1 mm could be made to effectively produce a very thin absorbent core.

An example of a sanitary napkin comprises a hydrophobic top sheet, a transfer layer, a pad of the absorbent structure of the present invention, and a liquid impervious bottom or back sheet. Suitable materials for top sheets, bottom sheets and transfer layers are known in the art. *See, e.g., U.S. Pat. No. 3,871,378 (Duncan).*

## EXAMPLES

Representative examples of the absorbent structures according to the invention are described here. Those of skill in the art will recognize that other combinations can be made according to the invention.

### A. Polyurethane Foam Formulations

Two polyurethane foam formulations were prepared. One incorporated superabsorbent polymer in a dispersion with the polyol and then formed the foam. Amounts are indicated as parts by weight based on 100 parts polyol.

|    | <u>Component</u> | <u>Manufacturer/Brand</u>  | <u>Foam A</u> | <u>Foam B</u> |
|----|------------------|----------------------------|---------------|---------------|
| 20 | Polyether polyol | Dow Chemical VORANOL 3137  | 100           | 100           |
|    | SAP              | Elf Atochem NORSOCRYL S-35 | 0             | 30            |
|    | Surfactant       | Witco/OSI NIAX L618        | 1             | 1             |

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|   |                  |                             |       |       |
|---|------------------|-----------------------------|-------|-------|
|   | Amine Catalyst   | Huntsman JEFFCAT ZF 53      | 0.11  | 0.11  |
|   | Tin Catalyst     | Witco/OSI FOMREZ C-2        | 0.16  | 0.16  |
|   | Water            | Deionized                   | 4.6   | 4.6   |
|   | Isocyanate       | Arco/Lyondell TD-80 Type II | 52.92 | 52.92 |
| 5 | Isocyanate Index |                             | 100   | 100   |

In the examples, grinding was done through cryogenic methods, although other known plastics grinding methods could be used with the invention.

B. Wood Pulp Fibers

For all absorbent structures that incorporated wood pulp, we used

10 Weyerhauser bleached Southern pine wood pulp fibers. The pulpboard was fed into a hammermill during the airlaid process.

C. Preparation of the Absorbent Core Structures

In these examples, foam particles and/or foam cell fragments were mixed together with wood pulp fibers in an air handler. Using Dan-Web airlay equipment, 15 the mixture was carried by air to rest upon a mesh screen and then was sprayed with a minor amount of AIRFLEX 108 ultra-low formaldehyde emulsion binder from Air Products and Chemicals, Inc. to form a nonwoven web. The resulting web was densified between calendar rolls to the desired density, then dried in an oven. Desired density for the examples was from 0.1 to 1.0 g/cm<sup>3</sup>, although other densities in the 20 range of 0.01 to 2.0 g/cm<sup>3</sup> could be used successfully.

Absorbent pad products were made by replacing the absorbent core found in Proctor & Gamble ALWAYS ULTRA with wings feminine hygiene absorbent pads with the airlaid nonwoven web of wood pulp fibers and foam particles/cell fragments.

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D. Analysis

The absorbent structure formed was placed into an absorbent article (a feminine hygiene pad) and tested against a control. The control was a Proctor & Gamble ALWAYS ULTRATHIN pad with wings. The structure of such pad is shown  
5 in FIG. 1.

Absorbency Rate is a measure of the time in seconds for a 10 ml quantity of a pigmented 0.9% saline solution to completely penetrate the top sheet of an absorbent product. Absorbency Rate was tested according to the following procedure:

- 10     • A one-inch diameter pouring ring was placed on the surface of the product to be tested.
- 15     • 10 ml. of pigmented 0.9% saline solution was measured into a graduated cylinder and quickly poured into the pouring ring.
- 20     • At the moment the solution is poured, a stop watch was used to start timing the rate of solution penetration. The stop watch measured time by one-hundredth of a second increments.
- 25     • The time in seconds was recorded as soon as the solution cleared the surface of the absorbent product.

Wicking is a measure of the longitudinal distance that a 10 ml. quantity of pigmented 0.9% saline solution travels along the absorbent core of the absorbent product. Wicking was tested by the following procedure:

- 25     • A one-inch diameter pouring ring was placed on the surface of the product to be tested.
- 30     • 10 ml. of pigmented 0.9% saline solution was measured into a graduated cylinder and quickly poured into the pouring ring.
- Once the solution was absorbed, the pouring ring was removed.
- After two minutes, the distance the fluid had travelled into the longest direction of the product was measured in centimeters.

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Retention (Re-wet) is a measure of the amount of pigmented 0.9% saline solution that transfers from an absorbent product that has received 10 ml. of solution to an absorbent medium placed on the surface of the absorbent product and held under load. Retention was tested by:

- Placing a one-inch diameter pouring ring on the surface of the absorbent product.
- Measuring out 10 ml. of saline solution and quickly pouring that solution into the pouring ring. The pouring ring is removed after the liquid was absorbed.
- A stop watch was started just as the liquid was poured. After five minutes, ten layers of Whatman #4 filter paper (of known tare weight) are placed on the surface of the absorbent article over the cross-sectional area at which the solution had been poured. A load of 0.5 psi was placed on top of the stack of filter paper.
- After fifteen seconds, the load and the filter paper were removed.
- The filter paper stack was weighed. The difference between the known tare weight of the paper before the test and that after the test represents the amount of fluid absorbed by the filter paper in grams.

Total Absorbent Capacity is a measure of the amount of pigmented 0.9% saline solution that an absorbent product can hold. To test Total Absorbent Capacity:

- Determine the initial weight of the dry absorbent product.
- Place the product into a large volume of pigmented 0.9% saline solution sufficient to submerge the product in the solution.
- Hold the absorbent product submerged in solution for two minutes.
- Remove and drain the product for one minute.
- Weigh the wet product and determine the weight difference between the dry product and the wet product. The difference represents the total absorbent capacity measured in grams.

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In the following Table, Example 1 is the control, a P&G ALWAYS ULTRATHIN pad with wings. The remaining examples include the absorbent structure according to the invention and show promising results even when no SAP or very small amounts of SAP were added. All airlaid samples according to the  
5 invention were made in a non-embossed state, but the control used an embedded airlaid. Embossing makes a difference in fluid handling characteristics. Even so, the foam airlaid samples showed an improvement from the standpoint of using less SAP. Thus, the absorbent products made with the absorbent structure according to the invention achieved equivalent performance at less cost.

TABLE

| Example <sup>1</sup>                    | 1          | 2     | 3     | 4      | 5                | 6                | 7                | 8                | 9                | 10               | 11               |
|---|------------|-------|-------|--------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Foam                                    | No<br>Foam | 20%   | 10%   | 10%    | 75%              | 75%              | 50%              | 90%              | 90%              | 90%              | 90%              |
| Pulp                                    | 100%       | 80%   | 90%   | 90%    | 25%              | 25%              | 10%              | 10%              | 10%              | 10%              | 10%              |
| SAP                                     | 1.0 g      | 0 g   | 0 g   | 0.02 g | 0.35 g           | 0.37 g           | 0.36 g           | 0.51 g           | 0.71 g           | 0.56 g           | 0.53 g           |
| Binder<br>A108                          | 20%        | 20%   | 20%   | --     | --               | --               | --               | --               | --               | --               | --               |
| Binder<br>192                           | --         | --    | --    | --     | 20%              | 20%              | 20%              | 20%              | 20%              | 20%              | 20%              |
| <hr/>                                   |            |       |       |        |                  |                  |                  |                  |                  |                  |                  |
| Foam Size                               | No<br>Foam | 2 mm  | 2 mm  | 2 mm   | 0.092"<br>screen | 0.032"<br>screen | 0.092"<br>screen | 0.092"<br>screen | 0.032"<br>screen | 0.092"<br>screen | 0.092"<br>screen |
| Sample<br>length (in)                   | 8.125      | 8.063 | 8.063 | 8.063  | 8.125            | 8.125            | 8.063            | 8.125            | 8.125            | 8.125            | 8.125            |
| Sample<br>width (in)                    | 2.75       | 2.69  | 2.69  | 2.69   | 2.75             | 2.69             | 2.75             | 2.69             | 2.69             | 2.75             | 2.75             |
| Sample<br>thickness<br>(in)             | 0.052      | 0.071 | 0.054 | 0.050  | 0.062            | 0.058            | 0.100            | 0.075            | 0.074            | 0.075            | 0.056            |
| Weight (g)                              | 2.6        | 1.15  | 1.05  | 0.95   | 1.85             | 1.95             | 2.85             | 2.26             | 3.15             | 2.50             | 2.36             |
| Basis<br>Weight<br>(g/yd <sup>2</sup> ) | 151        | 69    | 63    | 57     | 151              | 116              | 167              | 134              | 187              | 145              | 137              |

<sup>1</sup> Percentages are expressed as percent by weight of the absorbent structure. 0.092" screen yielded particles of 0.015" or 0.38 mm size. 0.032" screen yielded fragments of 0.005" or 0.127 mm size.

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| Example                      | 1     | 2     | 3    | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    |
|------------------------------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| absorption rate (sec.)       | 1.93  | 1.69  | 1.44 | 1.54  | 2.0   | 1.73  | 1.72  | 1.69  | 1.70  | 1.62  | 1.77  |
| Rewet (g)                    | 0.01  | 0.13  | 0.05 | 0.05  | 0.11  | 0.0   | 0.01  | 0.02  | 0.01  | 0.0   | 0.0   |
| Wicking (in)                 | 6.5   | 4.5   | 4.5  | 3.5   | 3.5   | 3.5   | 2.5   | 3.0   | 3.75  | 3.0   | 3.5   |
| Core capacity (g/g)          | 12.3  | 9.3   | 10.5 | 9.8   | 8.6   | 9.3   | 11.1  | 8.9   | 9.8   | 9.8   | 9.0   |
| dry (g)                      | 3.19  | 1.15  | 1.05 | 0.95  | 1.85  | 1.95  | 2.85  | 2.26  | 3.15  | 2.5   | 2.36  |
| wet (g)                      | 42.49 | 11.86 | 12.1 | 10.22 | 17.69 | 20.13 | 34.46 | 22.41 | 33.94 | 26.94 | 23.64 |
| density (g/in <sup>3</sup> ) | 2.24  | 0.75  | 0.90 | 0.88  | 1.34  | 1.54  | 1.29  | 1.38  | 1.95  | 1.49  | 1.89  |
|                              |       |       |      |       |       |       |       |       |       |       |       |
|                              |       |       |      |       |       |       |       |       |       |       |       |
|                              |       |       |      |       |       |       |       |       |       |       |       |

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In Examples 2-11, wicking length was not as long as the control (Example 1), but this was due to lack of embossing in Examples 2-11. Examples 6-11 exhibited improved absorbency rate and rewet over the control with less super absorbent polymer and less absorbent core material by weight in the absorbent structure.

- 5 Examples 2-5 show comparable absorption rate and core capacity to the control. Desired properties for an absorbent structure according to the invention are (a) fast absorption rate of 2 seconds or under; (b) low rewetting of about 0.1 g or less, preferably 0 g; (c) high liquid holding capacity in the core of about 9.0 g/g or higher; and (d) demonstrated wicking ability of about 3.0" or greater, preferably above about  
10 4.0".

The invention has been illustrated by detailed description and examples of the preferred embodiments. Various changes in form and detail will be within the skill of persons skilled in the art. Therefore, the invention must be measured by the claims and not by the description of the examples or the preferred embodiments.

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I claim:

1. An absorbent structure, comprising:

5 a plurality of polyurethane foam particles mixed together to form a nonwoven web  
with an outer surface and a central portion, wherein the web absorbs a liquid that contacts  
the outer surface into its central portion.

10 2. The absorbent structure of claim 1, wherein the foam particles are formed  
by grinding a polyurethane foam with a cell size in the range of 100 to 150 pores per  
linear inch to particles with a mean particle size in the range of about 0.10 to 2.6 mm.

15 3. The absorbent structure of claim 1, wherein the foam particles are formed  
by grinding a polyurethane foam with a cell size in the range of 60 to 90 pores per linear  
inch to particles with a mean particle size in the range of about 0.40 to 2.6 mm.

4. The absorbent structure of claim 1, wherein the foam particles are formed  
by grinding a polyurethane foam with a cell size in the range of 10 to 30 pores per linear  
inch to particles with a mean particle size in the range of about 0.70 to 2.6 mm.

20 5. The absorbent structure of claim 1, wherein the polyurethane foam is a  
hydrophobic polyurethane foam.

25 6. The absorbent structure of claim 1, wherein the polyurethane foam is  
formed from the reaction of one or more polyols with one or more isocyanates in the  
presence of a blowing agent and a catalyst and optionally other conventional additives,  
wherein one or more superabsorbent polymers are added to the polyol or polyols prior to  
forming the polyurethane foam.

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7. The absorbent structure of claim 6, wherein superabsorbent polymer is added to the polyol or polyols in an amount of from 10 to 35 % by weight based on the weight of the polyol.

5

8. The absorbent structure of claim 7, wherein superabsorbent polymer is added to the polyol or polyols in an amount of from 25 to 35% by weight based on the weight of the polyol.

10

9. An absorbent structure, comprising:

a plurality of polyurethane foam particles mixed together with a plurality of wood pulp fibers to form a nonwoven web with an outer surface and a central portion, wherein the web absorbs a liquid that contacts the outer surface into its central portion.

15

10. The absorbent structure of claim 9, wherein the foam particles are formed by grinding a polyurethane foam with a cell size in the range of 100 to 150 pores per linear inch to particles with a mean particle size in the range of about 0.10 to 2.6 mm.

20

11. The absorbent structure of claim 9, wherein the foam particles are formed by grinding a polyurethane foam with a cell size in the range of 60 to 90 pores per linear inch to particles with a mean particle size in the range of about 0.40 to 2.6 mm.

25

12. The absorbent structure of claim 9, wherein the foam particles are formed by grinding a polyurethane foam with a cell size in the range of 10 to 30 pores per linear inch to particles with a mean particle size in the range of about 0.70 to 2.6 mm.

13. The absorbent structure of claim 9, wherein the polyurethane foam is a hydrophobic polyurethane foam.

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14. The absorbent structure of claim 9, wherein the polyurethane foam is formed from a reaction of one or more polyols with one or more isocyanates in the presence of a blowing agent and one or more surfactants and optionally other conventional additives, wherein one or more superabsorbent polymers are added to the polyol or polyols prior to forming the polyurethane foam.

15. The absorbent structure of claim 14, wherein superabsorbent polymer is added to the polyol or polyols in an amount in the range of from 10 to 35 % by weight based on the weight of the polyol.

10

16. The absorbent structure of Claim 15, wherein super absorbent polymer is added to the polyol or polyols in an amount in the range of from 25 to 35% by weight based on the weight of the polyol.

15

17. The absorbent structure of claim 9, wherein the wood pulp fibers comprise about 10 to 25% by weight and foam particles comprise about 90 to 75% by weight of the absorbent structure.

20

18. The absorbent structure of claim 9, wherein wood pulp fibers comprise about 75 to 90 % by weight and foam particles comprise about 25 to 10 % by weight of the absorbent structure.

25

19. The absorbent structure of claim 9, wherein wood pulp fibers comprised about 25 to 50% by weight and foam particles comprise about 75 to 50% by weight of the absorbent structure.

20. The absorbent structure of claim 9, wherein a binder fiber is incorporated into the nonwoven web for thermal bonding.

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21. An absorbent structure, comprising:

a plurality of polyurethane foam cell strands mixed together with a plurality of wood pulp fibers to form a nonwoven web with an outer surface and a central portion, wherein the web absorbs a liquid that contacts the outer surface into its central portion.

5

22. The absorbent structure of claim 21, wherein the polyurethane foam used as the source of the strands is a hydrophobic polyurethane foam.

10

23. The absorbent structure of claim 21, wherein the polyurethane foam used as the source of the strands is formed from a reaction of one or more polyols with one or more isocyanates in the presence of a blowing agent and one or more surfactants and optionally other conventional additives, wherein one or more superabsorbent polymers are added to the polyol or polyols prior to forming the polyurethane foam.

15

24. The absorbent structure of claim 21, wherein the superabsorbent polymer is added to the polyol or polyols in an amount in the range of from 10 to 25 % by weight based on the weight of the polyol.

20

25. The absorbent structure of claim 21, wherein the wood pulp fibers comprise about 10 to 25% by weight and foam cell strands comprise about 90 to 75% by weight of the absorbent structure.

25

26. The absorbent structure of claim 21, wherein wood pulp fibers comprise about 75 to 90 % by weight and foam cell strands comprise about 25 to 10 % by weight of the absorbent structure.

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27. The absorbent structure of claim 21, wherein wood pulp fibers comprise about 25 to 50% by weight and foam cell strands comprise about 75 to 50% by weight of the absorbent structure.

5

28. The absorbent structure of claim 21, wherein a binder fiber is incorporated into the nonwoven web for thermal bonding.

10 29. An absorbent article incorporating as one layer the nonwoven web of  
claim 1.

30. An absorbent article incorporating as one layer the nonwoven web of  
claim 9.

15 31. An absorbent article incorporating as one layer the nonwoven web of  
claim 21.

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Fig. 1.  
(Prior Art)

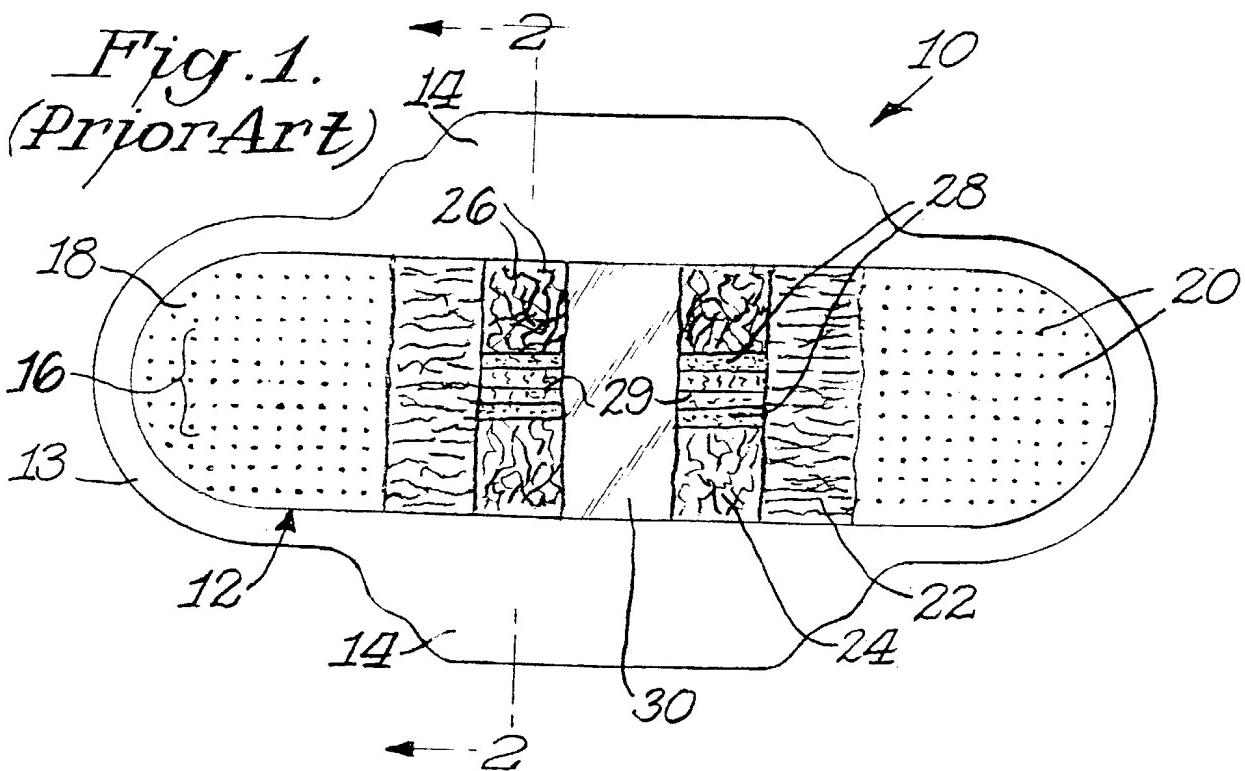


Fig. 2.  
(Prior Art)

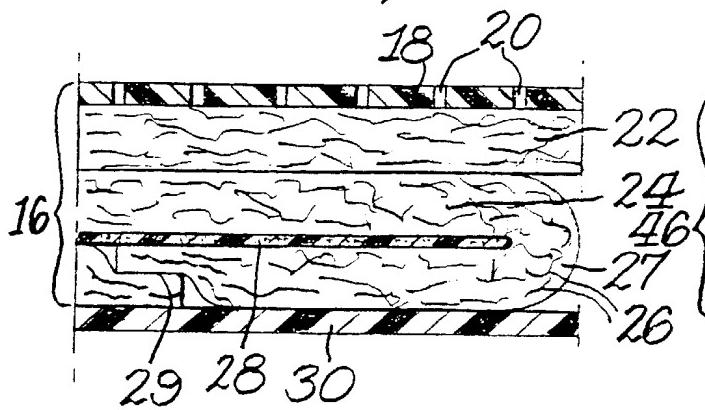


Fig. 4

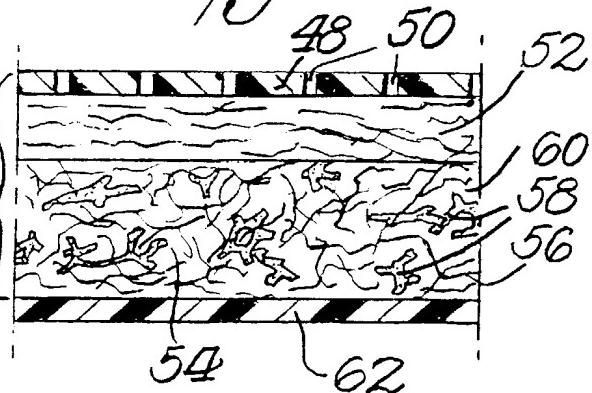
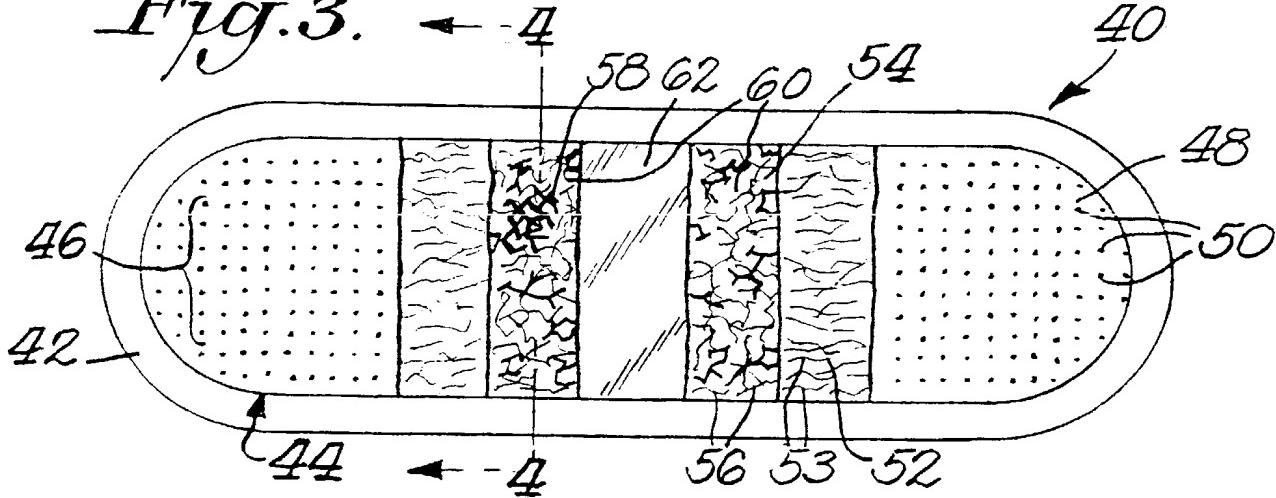
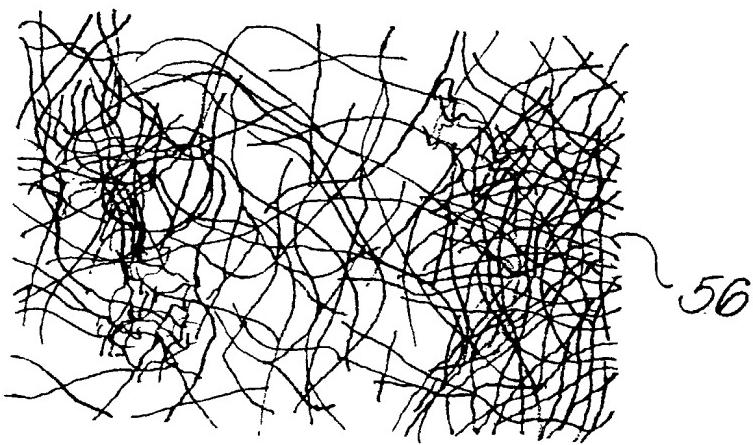


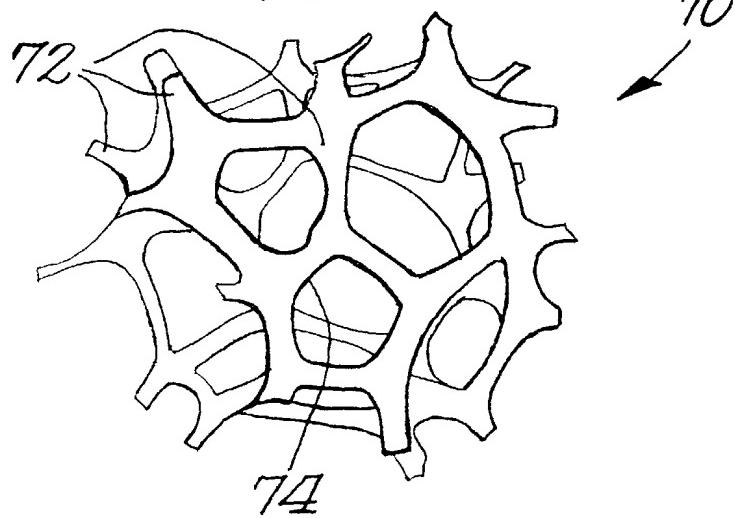
Fig. 3.



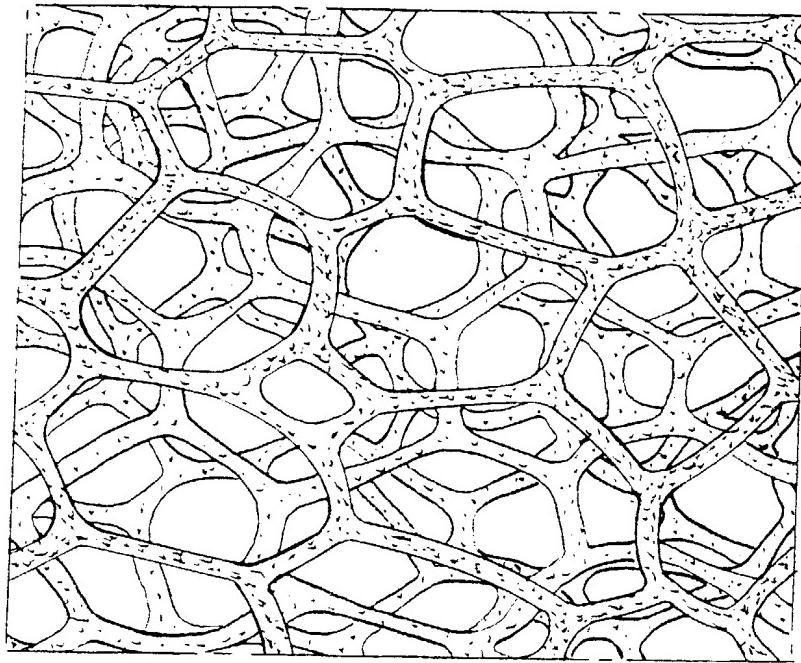
*Fig. 5.*



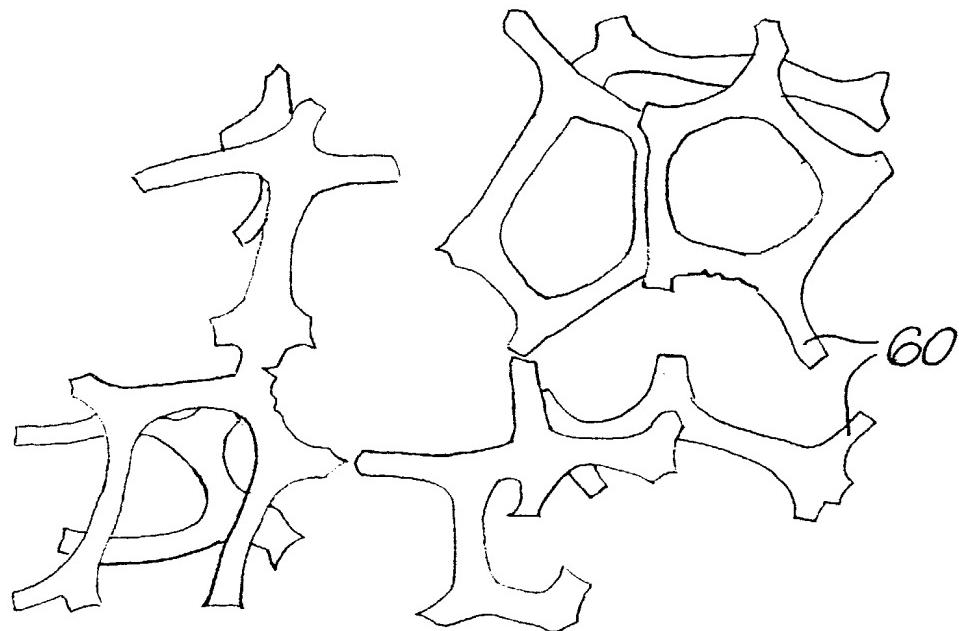
*Fig. 6.*



*Fig. 7.*



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*Fig. 8.**Fig. 9.*

# INTERNATIONAL SEARCH REPORT

Inte onal Application No  
PCT/US 00/16563

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 A61L15/60

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 A61L C08J D21H D21D D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal, PAJ, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|------------|---|-----------------------|
| X          | US 4 395 332 A (KLEIN MAX)<br>26 July 1983 (1983-07-26)<br>claims 1-3,16<br>---   | 1,5,9,<br>13,21,22    |
| X          | US 4 182 649 A (HAYES NORMAN J ET AL)<br>8 January 1980 (1980-01-08)<br>column 1, line 63 - last line<br>example 2<br>claims<br>1,3,5-7,9-14,16-19,21-24,26-30,33-35<br>--- | 1,9,20,<br>21         |
| X          | GB 1 058 932 A (FARBENFABRIKEN BAYER<br>AKTIENGESELLSCHAFT)<br>15 February 1967 (1967-02-15)<br>examples 1,2<br>claims<br>---   | 1,9,20,<br>21         |
|            |   | -/-                   |

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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Date of the actual completion of the international search

Date of mailing of the international search report

5 October 2000

13/10/2000

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## INTERNATIONAL SEARCH REPORT

Inte  
nal Application No  
PCT/US 00/16563

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
|----------|--|-----------------------|
| Y        | US 5 840 780 A (WILSON ROBERT N)<br>24 November 1998 (1998-11-24)<br>column 6, line 6 - line 25<br>claims<br>-----                   | 1,5-26                |
| Y        | US 4 610 678 A (GOLDMAN STEPHEN A ET AL)<br>9 September 1986 (1986-09-09)<br>cited in the application<br>examples<br>claims<br>----- | 1,5-26                |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

|                 |                     |
|-----------------|---------------------|
| Inte            | onal Application No |
| PCT/US 00/16563 |                     |

| Patent document cited in search report | Publication date | Patent family member(s)   | Publication date   |
|--|------------------|---|--|
| US 4395332                             | A 26-07-1983     | AT 375273 B<br>AT 473179 A<br>AU 532041 B<br>AU 4859879 A<br>BE 877538 A<br>BR 7904228 A<br>CA 1134755 A<br>CH 660981 A<br>DE 2927407 A<br>DK 286579 A<br>FI 792150 A<br>FR 2430251 A<br>GB 2024886 A, B<br>IL 57710 A<br>IT 1118155 B<br>JP 1518091 C<br>JP 55020691 A<br>JP 63066248 B<br>MX 7135 E<br>NL 7905308 A<br>NO 792252 A, B,<br>SE 436472 B<br>SE 7905929 A<br>ZA 7903272 A | 25-07-1984<br>15-12-1983<br>15-09-1983<br>15-01-1981<br>07-01-1980<br>18-03-1980<br>02-11-1982<br>30-06-1987<br>17-01-1980<br>08-01-1980<br>08-01-1980<br>01-02-1980<br>16-01-1980<br>30-11-1982<br>24-02-1986<br>07-09-1989<br>14-02-1980<br>20-12-1988<br>28-07-1987<br>09-01-1980<br>08-01-1980<br>17-12-1984<br>08-01-1980<br>30-07-1980 |
| US 4182649                             | A 08-01-1980     | US 4110508 A  | 29-08-1978   |
| GB 1058932                             | A                | FR 1514957 A  | 16-05-1968   |
| US 5840780                             | A 24-11-1998     | US 5624971 A<br>AU 3249597 A<br>WO 9800182 A  | 29-04-1997<br>21-01-1998<br>08-01-1998   |
| US 4610678                             | A 09-09-1986     | AT 47662 T<br>AU 581842 B<br>AU 2540584 A<br>BR 8401093 A<br>CA 1241570 A<br>DE 3480324 D<br>DK 138884 A<br>EG 15591 A<br>EP 0122042 A<br>ES 278081 U<br>ES 530442 D<br>ES 8506475 A<br>FI 840965 A, B<br>GB 2140471 A, B<br>GR 82640 A<br>HK 30887 A<br>IE 55143 B<br>JP 2512415 B<br>JP 59204956 A<br>KR 9202936 B<br>KR 9205720 B<br>MX 165135 B<br>MY 8388 A<br>PH 20631 A          | 15-11-1989<br>09-03-1989<br>13-09-1984<br>16-10-1984<br>06-09-1988<br>07-12-1989<br>11-09-1984<br>30-04-1987<br>17-10-1984<br>16-04-1985<br>16-06-1985<br>16-11-1985<br>11-09-1984<br>28-11-1984<br>07-02-1985<br>24-04-1987<br>06-06-1990<br>03-07-1996<br>20-11-1984<br>10-04-1992<br>16-07-1992<br>28-10-1992<br>31-12-1988<br>06-03-1987 |